Gestão & Regionalidade

DOI: https//doi.org/10.13037/gr.vol37n112.6011

Received: 25/04/2019 | Accepted: 26/01/2021

Innovative Effort and Learning Processo of the Post-harvest Mechanical Metal Industry from Panambi

Esforço Inovativo e Processo de Aprendizado da Indústria Metal Mecânica Pós-Colheita de Panambi

Fabiano Geremia[i]
Orcid: https://orcid.org/0000-0001-8263-5795

Thales de Oliveira Costa Viegas[ii]
Orcid: https://orcid.org/0000-0003-1435-171X

Claudio José Silva Leão[iii]
Orcid: https://orcid.org/0000-0003-3927-9144

Rafael Alves de Moura[iv]
Orcid: https://orcid.org/0000-0001-6964-2907

Abstract
This paper analyzes the post-harvest mechanical metal industry's learning and innovation processes (in Panambi - RS). Brazilian industrialization favored the formation of productive capacity, to the detriment of fostering innovative capacity. However, innovation processes enhance companies and nations' development, especially in a competitive environment that requires competencies, constant learning, and the ability to innovate. It is an exploratory study of industrial companies, using a non-probabilistic sample questionnaire, with questions adapted from the REDESIST's questionnaire. The results point that there are: a local productive and innovative system; division of labor and productive specializations; technological and organizational training effort; local relations; benefits of proximity; and territorial organization. Innovative efforts are incremental and imitative. There is significant cooperation between companies, involving support institutions, which demonstrates synergies between them, capable of densifying the production system, promoting a virtuous development circle.
Keywords: technological innovations; learning processes; metal mechanics industry.

Resumo
Este artigo analisa os processos de aprendizagem e inovação da indústria metal mecânica pós-colheita de Panambi (RS). A industrialização brasileira privilegiou a conformação de capacidade produtiva, em detrimento do fomento à capacidade inovativa. Contudo, os processos de inovação potencializam o desenvolvimento de empresas e nações, especialmente num ambiente competitivo que requer competências, constante aprendizado e habilidade para inovar. Este é um estudo exploratório de empresas industriais, com aplicação de questionário em amostra não probabilística, com questões adaptadas do questionário da REDESIST. Os resultados apontam a existência de: um sistema produtivo e inovativo local; divisão do trabalho e especializações produtivas; esforço de capacitação tecnológica e organizacional; relações locais; benefícios da proximidade; e organização territorial. Os esforços inovativos são incrementais e imitativos. Constata-se uma cooperação significativa entre empresas, envolvendo instituições de apoio, o que demonstra a existência de sinergias, capazes de adensar o sistema produtivo, com estabelecimento de círculo virtuoso de desenvolvimento.
Palavras-chave: inovações tecnológicas; processos de aprendizagem; indústria metal mecânica.

[i] Universidade Federal da Fronteira Sul (UFFS), Brasil. E-mail: fageremia@gmail.com
[ii] Universidade Federal de Santa Maria (UFSM), Brasil. E-mail: thales.viegas@ufsm.br
[iii] Universidade Federal de Santa Maria (UFSM), Brasil. E-mail: claudio.leao@ufsm.br
[iv] Universidade Federal de Santa Maria (UFSM), Brasil. E-mail: rafaelalvesdemoura@hotmail.com

1 INTRODUCTION

The changes in the competitive environment in recent decades have altered the traditional way of organization and functioning of economies and production. Technological advances arising from the consolidation of the information technologies and communication paradigm, since the end of the 70s, have changed considerably the means of relationship among economic agents, mainly altering borders and productive possibilities, which transcends the individual company.

In this context, two essential aspects are mentioned in the process of introducing innovation. The first concerns the role of innovation and knowledge. In a more rigorous economic analysis, these elements usually deserve special attention, notably in the models and analyzes developed in the area of innovation economics, which is associated with the neo-Schumpeterian / evolutionist school. This school of economics thought has been offering important contributions to the understanding of the central role played by innovations and interactive learning, as well as studies that help to understand the ways in which companies establish interactive relationships with the most varied economic agents. Secondly, the role of advances in information technologies and communication is highlighted, which plays a major role in allowing the flexibility of the different stages of the production process, highlighting the importance of understanding the learning dynamics in companies.

This paper analyzes the characteristics of innovative effort and learning processes of the post-harvest metal mechanic industry in Panambi - RS. The study discusses the interrelationships established between companies and institutions in the delimited geographical and institutional spaces, as well as analyzes the characteristics and possibilities of competitive insertion of micro, small and medium-sized companies in the local metal mechanic segment. The hypothesis of the study is that the formation and the productive trajectory of this industry, in the region under study, allow cooperative actions in the productive, institutional and technological scope which contribute to the accumulation of knowledge and skills that strengthen the local innovative system. Although the results have greater coverage, the study is limited to the specific case of companies that form the metal mechanic industry located in Panambi - RS. This region has an industrial structure with a high degree of diversification in the metal mechanical production system, which is formed by a significant number of micro and small companies operating in the surroundings of large companies that are a reference in the metal mechanical production in the post-harvest.

2 CONCEPTUAL ASPECTS OF COMPETITIVENESS, LEARNING, INNOVATION AND COOPERATION

Competitiveness has been described as a multidimensional and relative concept, which can be assessed at three different levels, namely: country, sector and company. The competitiveness of a company depends on the connection among the country, the sector and the organization’s competitiveness. It is manifested in different levels of profit and market share, as well as in the company's long-term survival. Productivity is a relevant measure of competitiveness, although it is only one of its aspects (DRESCH; COLLATTO; LACERDA, 2018). In the understanding of Bhawsar and Chattopadhyay (2015) the definition of competitiveness at the company level is the company's ability to meet customer requirements at an appropriate level of profitability. It is the competence to offer products and services perceived by customers as of greater value than those offered by competitors.

Considering that it is companies, and not countries that compete globally, competitiveness at the firm level is essential. However, conventional economic

indicators tend not to assess firms' competitiveness. Competitiveness is a key (and multidimensional) concept, as it determines the conquest of new markets and the performance of organizations. There are three main constitutive elements of the notion of competitiveness: i) to compete; ii) to connect and; iii) to change. In practice, competitiveness, in dynamic terms, corresponds to: i) ability to meet consumer demand in terms of punctual delivery, price, quality and quantity, in the niche markets in which it operates; ii) competence to sustain these high standards over time, adjusting to changes in the economic environment; iii) ability to stay connected with relevant market information and novelties. The capabilities and processes are relevant aspects for the companies 'competitiveness (FALCIOLA; JANSEN; ROLLO, 2020).

In the concrete national reality, between 2004 and 2013, Brazilian economy grew above the world average and generated benefits for several sectors of the economy, especially the manufacturing sector, including a great proportion of high and medium technological intensity segments. However, a significant portion of the growth demand has leaked to foreign countries, through imports associated with several manufacturing segments, in particular those of high and medium technological density. In this period, Brazilian industry lost competitiveness, manifested in the negative growth of labor productivity and in the commercial deficits in different industrial niches (MORCEIRO, 2016).

Much of the competitiveness growth of industry in Brazil is the result of successful efforts to accumulate technological and innovation capacity, capable of raising the productivity of companies. Industrial competitiveness is associated with the following elements: i) accumulation of technological capacities; ii) technological learning mechanisms (intra and interorganizational); iii) "impacts" of the accumulation of technological capacities; iv) indirect influences, at the level of industry and economy, in the accumulation of technological capacity of companies, which correspond to the role played by institutional structures in the technological and industrial development of a country. The competitiveness associated with learning are essential to absorb knowledge, adapt and improve technologies already present in the market. The challenge is that the frontiers of research, knowledge and technology often advance, becoming a moving target, so that companies located in emerging countries have to learn and accumulate technological capacity at a higher pace than their competitors of the leading global countries in relevant technologies (FIGUEIREDO; PINHEIRO, 2016).

Technological capacity is a set of resources maintained by companies, which require technological learning, in order to form the basis of companies' production and innovation activities. In this context, the metal mechanic sector needs continuous and significant efforts to train its human resources, in general, and training in Basic Industrial Technology (BIT), in particular. The process of internalization of the BIT infrastructure, on the part of the companies, forms the basis for the continuous improvement processes, necessary to increase their level of competitiveness and the innovation capacity. The data analysis of the metal mechanic industry in Rio de Janeiro pointed out a weakness in capacity in terms of BIT in most companies in the state. There is evidence that this picture is common to companies in this industry, located all over Brazil. However, it must be recognized that raising the technological standard is difficult for national-based companies, especially for smaller ones, which is why government incentives aimed at this purpose are important (MENDES; FERREIRA, 2018).

Economic agents carry out innovations because they believe that when they are successful in these initiatives, they will be very well compensated for it and, not necessarily, for the unfeasibility of their

previous modus operandi. In this regard, Schumpeter pointed out that innovation is the driving force behind technological development and economic change (NELSON, 2017). The relationship between innovation and competition is central to evolutionary and Neo-Schumpeterian approaches to economic change and market dynamics. The most innovative companies, or technologically more apt, tend to dominate a market over time. This heterogeneity among companies in the same sector is often associated with the knowledge gap in a context of interaction and exchange with other companies. Access to external knowledge can occur, for example, by: i) spending on R&D, payment of licensing fees, purchase of patents; ii) mergers and acquisitions in R&D; iii) cooperation in research or in the exchange of formal / informal knowledge. Neo-Schumpeterian authors dedicated themselves to understanding the dynamic nature of economic phenomena, ranging from individual technology (associated with capital goods or consumer goods) to changes in entire technological systems (CANTNER, 2017).

In Brazil, the better competitive performance of companies that made technological efforts and learning in R&D, before and after liberalization, corroborates the hypothesis of the Neo-Schumpeterian theory, according to which the accumulated knowledge - obtained through their learning, research, development and innovation - provides dynamic capacity to face an evolving technological regime (GUERRERO; FONSECA; AREND, 2017). Innovation networks are based on complementarity among companies. A dynamic modern economy is characterized by a strong interrelationship among heterogeneous agents and with distinct knowledge, in a context in which combined technologies are the rule and not the exception. In general, the viability of a company is low to follow the development of all technologies relevant to its business, so that it is essential to access external sources of knowledge. Consequently, innovation networks are becoming increasingly important as means of generating and coordinating industrial research and development (R&D) when exploring ascendant and descendant complementarity (DOPFER; POTTS; PYKA, 2017).

The notion of technological learning corresponds to the accumulation of technological skills resulting from intra-company efforts, and external elements, which result from the interaction with other organizations. Technological Learning processes include the processes of: i) external knowledge acquisition; ii) internal knowledge acquisition; iii) socialization of knowledge; iv) codification of knowledge. They also include capabilities: i) technological; ii) production and; iii) external links. Technological capacity is associated with essential resources to generate and manage technical changes, involving skills, knowledge, experiences and institutional structure. Such resources are stored in three components: human resources, organizational configuration and technical-physical systems. Codification and knowledge sharing initiatives within companies and among them expand the capacity to innovate. Competition between companies encourages innovation, which requires knowledge learned (systematically) and accumulated by these organizations (IACONO; NAGANO, 2019).

The specialized literature has identified the different learning mechanisms that will be addressed below. Learning by doing or learning by producing, which can occur through trial and error and is fundamental to improving the company's R&D efforts; learning by using is manifested in the experience accumulated by the user and is able to be transformed into new products only if the producer has contact with those who use it; learning by searching (searching for new solutions via R&D, for example); learning

by interacting (interacting with external knowledge sources such as customers, suppliers or research institutions, for example), which reinforces the links between producer and user (by increasing the effectiveness of these information exchange channels), creates specific know-how, as well as generating a virtuous circle by promoting the constitution of poles of competitiveness and the better use of technological opportunities; learning by subcontracting (in the interfaces for the subcontracting of goods or services); learning by imitation (imitation / copying of competitors), which can occur via reverse engineering, for example. Instead of being exclusive, some of these processes are interdependent. They may be able to generate positive reinforcements and beneficial feedback for innovation, especially if they help to recognize bottlenecks or specific problems in production or in the constitution of the product or service (LUNDVALL, 2016; BETIM *et al*, 2018).

Essentially and objectively, innovation can be understood through different types: i) product, service, process, organizational or technological innovation; ii) radical or incremental innovation; iii) innovation for the company or the market. The definition of each of them will be presented below, respectively. Innovation can manifest itself in a product / service with new characteristics. 'Technological innovation 'alters the technical characteristics (physical or not) of a product or process, with the aim of improving its results. 'Process innovation '(technological or not) can involve changes in flows (of materials or information) or increased efficiency in the use of inputs and in the set of activity / organization. Similarly, 'organizational innovation 'seeks to rearrange the allocation of company resources to enhance its performance, often using more modern information technologies. 'Radical innovation 'is that disruptive one which promotes significant change regarding the previous technical paradigm, making it obsolete (process of creative destruction). The 'incremental innovation', on the other hand, adds improvements to a product or process, which follows an evolutionary path accumulating improvements originated from several sources of knowledge combined. The 'innovation for the company 'is one in which the organization learns, acquires technology or copies a process (for example) that is new to it, but is already used in the economy. "Innovation for the market" is the novelty introduced in the world or in the local market by the company that uses a certain process or produces and sells (on the market) a very different product from that offered by its competitors (COSTA, 2017).

Concerning the phenomenon of Cooperation, there are different ways in which it can manifest itself. Cooperation is the union of efforts (resources) in the same direction, seeking the formation of synergies and better results, therefore it can occur among different organizations or even among different departments of the same company. More intense business competition often requires more cooperative efforts to facilitate product or process innovations. The extent of cooperation can vary according to the type of product innovation and the most important innovations usually involve at least some elements of cooperation. Cooperation is a way of learning, for example, by interaction between producer and user, which can reduce uncertainties for both sides, by enabling: greater adherence to the user's need; the expansion of product quality and reliability and; raising the innovative capacity of the manufacturer. This latter result can also be obtained with the cooperation (in R&D efforts or professional qualification) established with research and teaching institutions, such as the relationship between university and company (LUNDVALL, 2016).

Finally, it should be noted that the theoretical framework adopted in this work was the Neo-Schumpeterian one, which

highlights the process of transformation of the capitalist system as a result of innovations carried out by economic agents. In the neo-Schumpeterian conception, economic development is the result of new technologies, new processes and products conformation. The capitalist system interpreted by Schumpeter is portrayed as an evolutionary system, in which innovative companies can survive and develop, while companies that are not innovative tend to disappear. This process was called "creative destruction", in which the introduction of innovation implies the obsolescence of the standard (technical or technological) ruling so far. It should be noted that the metal mechanic industry has a significant degree of technological maturity. Even so, it is recurrently subject to considerable changes in its production base, processes and products. The next section will discuss the main characteristics of this industrial segment.

2.1 METAL MECHANIC INDUSTRY

In the early years of the Republic (1900-1940), the economic debate was centered on two theoretical currents: the group that believed in the development of industry and the group that defended the development of export agriculture, which was the hegemonic view. The first group brought an expanded reflection by associating the country's economic development and industrialization, while the second reconstructed the dominant discourse, dated from the empire, from the national agricultural vocation, theoretically related to the Ricardian tradition of comparative advantages (CURADO, 2013).

The global economic crisis that dragged on for some years of the 1930s created the conditions for Brazil to adopt the Import Substitution Industrialization (ISI) model. The Import Replacement Process (PSI) would save foreign exchange in a context of external strangulation, which influenced the terms of trade and affected the country's ability to buy inputs and (essential) finished products from abroad (FONSECA; SALOMÃO, 2017). In this context, the domestic transformation industry creates its foundations to develop, which includes the metal mechanic system. However, Carvalho (2020) compiles some contradictions of the PSI, pointing out that it contains the genesis of its own collapse. First, ISI restores, to a new level, the tendency to external strangulation typical of economies that have not completed their industrialization. Second, with the advance of industrialization, new demands are emerging associated with the import of several kinds of inputs, which are necessary for the horizontal or vertical expansion of the country's industrial park. These are some of the reasons that made it difficult for ISI to deepen in Latin American countries.

The development of the national industry, initiated in the first decades of the 20th century, was enhanced in an agrarian-export context. There is no consensus in the literature on the origin of the country's manufacturing industry, but the capital accumulation required for the development of manufacturing in Brazil, occurs in the agricultural export sector and is enhanced by proto-developmental and developmental public policies (explicit or not), with fomentation effects to industry (FONSECA; SALOMÃO, 2017).

Dias (2018b) recalls that the metal mechanic industry is constituted in Brazil in a very connected way to the agricultural export sector, manufacturing agricultural machinery, equipment and implements. It is worth mentioning that, in the 1920s, the transition from the agricultural economy to the industrial economy began, which gained internal dynamism. The development of the metal mechanic industry in the region was boosted, especially after 1950, when the accelerated process of modernization of agriculture and agribusiness began, verified at the time. Around the larger and more dynamic industrial companies, several other metallurgical companies were formed, which supplied components and incorporated new processes, products and

technological innovations from the driving companies in the region.

The transformations that took place in the industry in the 1990s, according to Krein, Oliveira and Filgueiras (2019), are associated with three trends in contemporary capitalism, namely: the phenomena of globalization, hegemony of neoliberalism and productive restructuring. In this contemporary context, a dynamic of expansion of production has prevailed at levels below previous periods of capitalism, associated with the process of financialization of the economy. There is a greater speed of growth in the income of capital detached from the increase in production.

The metal mechanic industry is heterogeneous and is inserted in almost all productive subsystems. Consequently, this set of industrial activities is difficult to be aggregated, given the diversity of the production chains regarding the following aspects: size, product, process, capital or labor intensity, among others. Therefore, it can be classified (aggregated) in two ways. The first lists the similarities of the products of this production system and the second considers the characteristics and peculiarities of the production processes. Even within the machine tool segment, in particular, there is great technological and competitive heterogeneity. There are companies (leaders and followers) with the capacity to adapt and to assimilate knowledge, supported by R&D activities. Another group of companies has passive and imitative technological strategies with low innovative efforts (GUERRERO; FONSECA, 2018).

In general, metal mechanic industry has a strong concentration of capital, reinforced through mergers and acquisitions. The productive concentration enables gains of scale, marketing actions, large investments, as well as the innovative effort. Therefore, this productive segment is invariably dominated by large companies, with competitive insertion on a global level. The presence of small and medium-sized companies occurs marginally, acting in certain stages of the production process, subcontracted by large companies and / or present in specific market niches.

Cattaruzzo (2020) recalls that Pavitt was a pioneer in the industrial analysis of distinct sectors, classifying them according to the relative importance of certain determining dimensions for their technical advancement. Based on Pavitt's taxonomy framework, it is possible to classify the metal mechanic industry as: a) intensive production firms (shipbuilding, vehicle engines, etc.), which are characterized by prioritizing innovations in their processes of production; b) specialized suppliers (mechanical industry, engineering instruments, etc.), an activity in which the main focus is the innovation of products that will be used in other segments; c) science-based companies (electronics, etc.), which consist of technological innovations arising from scientific development and R&D activities. The classification proposed by Pavitt helps in the understanding of metal mechanic industry, because, based on it, it is possible to highlight the differences found in the subsystems that are part of the activity, including the productive segments and products. These differences point out the difficulties in classifying and analyzing the activities developed.

The metal mechanic industry is responsible for the production of capital goods, so that its evolution depends on the stimuli generated inside its own industrial park. In practice, the innovative effort of the industry and the geographical proximity to specialized suppliers allow the exchange of tacit knowledge, which enhances the competitive performance of firms in the face of international competition. In addition, the rate of gross fixed capital formation and innovations determine the pace of development of the metal mechanic production system. However, there is a significant heterogeneity of capital goods, which are due to the varied characteristics of the sector's products. The following elements are examples of it: tailor-made

products manufacturing, on demand, as well as standardized products, manufactured in scale or even serial capital goods. It is clear, therefore, that the pattern of competition for each of these subsystems is significantly distinct, since the main determinants of competitiveness may be appreciably different in each market niche in the sector. For example, economies of scale are essential in the production of serial capital goods. Meanwhile, in the production of capital goods on demand, the specialization and flexibility of the production process are fundamental for the competitive insertion in the industry (STALLIVIERI, 2004). Following, the methodology of this research will be presented.

3 METHODOLOGICAL PROCEDURES

This study has an exploratory character, by carrying out field research in a non-probabilistic sample of companies from the metal mechanic industry in Panambi - RS. The questionnaire used in the research was structured in such a way that the companies indicated a degree of importance, degree of difficulty or degree of knowledge for each alternative presented in the questionnaire. The questions were adapted from the questionnaire of the Research Network on Local Productive and Innovative Systems and Arrangements (REDESIST - from the Institute of Economics of the Federal University of Rio de Janeiro). According to RAIS (2016) there are 106 companies in the metal mechanic industry in the city under study. The sample, composed of twenty-two (22) companies, was obtained through contacts with the companies interested in answering the questionnaire, then they were grouped according to their size, according to SEBRAE methodology.

The main objective of the applied questions was to identify the innovative effort of the post-harvest metal mechanic industry in Panambi. The research identified the following elements: a) the effort to introduce technological innovations; b) the challenges associated with hiring qualified professionals; c) difficulties in selling production; d) the determining factors of competitive capacity; e) the importance of human resources training activities; f) the difficulties of producing with quality; g) difficulties related to costs or lack of working capital; h) the importance of the cost of purchasing machinery and equipment; i) the relevance of access to raw materials; j) local advantages, and; k) the sources of information used by companies.

The questionnaire was applied between April and June of 2018, with its owners and / or managers. The answers were provided directly by the main managers of the companies, which served to provide a better understanding of production, competitiveness and the innovative effort carried out by the referred manufacturing organizations. The questionnaire was adapted in order to obtain answers regarding the degree of importance or difficulty, associated with the aspects mentioned above, so that the respondent could assign a value between 0 and 3 in the responses, according to the degree perceived by him. Indicators were built based on the weighted average of the responses obtained in the survey with companies. When answering the questionnaire, the representatives of the companies attributed a degree of importance to each item, which could be zero, low, medium or high. The weighting was done as follows: “0 * Null number + 0.30 * Low number + 0.6 * Average number + High number / Number of companies that answered the questionnaire. The weighted average varies between 0 and 1, where 0 is considered null and gradually up to 1 with maximum importance.

The companies were separated into three groups, according to their size: small, medium and large company. The classification criteria for the size of the company followed the taxonomy adopted

by Sebrae, based on the number of employees. The companies are not identified in this study, since the information provided is strategic for these companies.

4 ANALYSIS: INNOVATIVE EFFORT, LEARNING PROCESSES AND COOPERATION IN THE METAL MECHANIC INDUSTRY OF PANAMBI / RS

Panambi is located in the northwest region of the state of Rio Grande do Sul. It is known for its productive specialization in the metal mechanic industry, in the segment of machinery and equipment for the agricultural sector. The geographical location is considered a competitive advantage, since the city belongs to a region with a high share of agricultural production and a relative proximity to the state capital. From the 60s of the last century, this industry was concentrated, essentially, in the production and generation of solutions for the post-harvest (drying, storage and storage of cereals).

The historical process of this productive specialization dates back to the beginning of the 20th century, with the arrival of German immigrants, who brought small industrial enterprises related to tooling for agricultural production. The first family businesses started around the 1920s (blacksmiths). The emergence of commerce and companies in general occurs, in a large extent, due to the accumulated knowledge brought by immigrant families. According to Dias (2018b), the propensity to undertake and the strategic vision of the region in Rio Grande do Sul is associated with non-Iberian European immigrants, who fostered activities with very close links between agriculture and industry, leading to the emergence of several companies associated with the supply of equipment for agriculture and livestock, as well as those employed in the transformation of primary goods coming from this activity. This contributed to the economic and regional development of the productive system analyzed in this study.

4.1 Analysis: learning processes

In this section, the learning processes, training and qualification of human resources carried out by the companies studied will be discussed. The observations consist of identifying the different degrees of importance conferred by each company, which were analyzed according to their sizes.

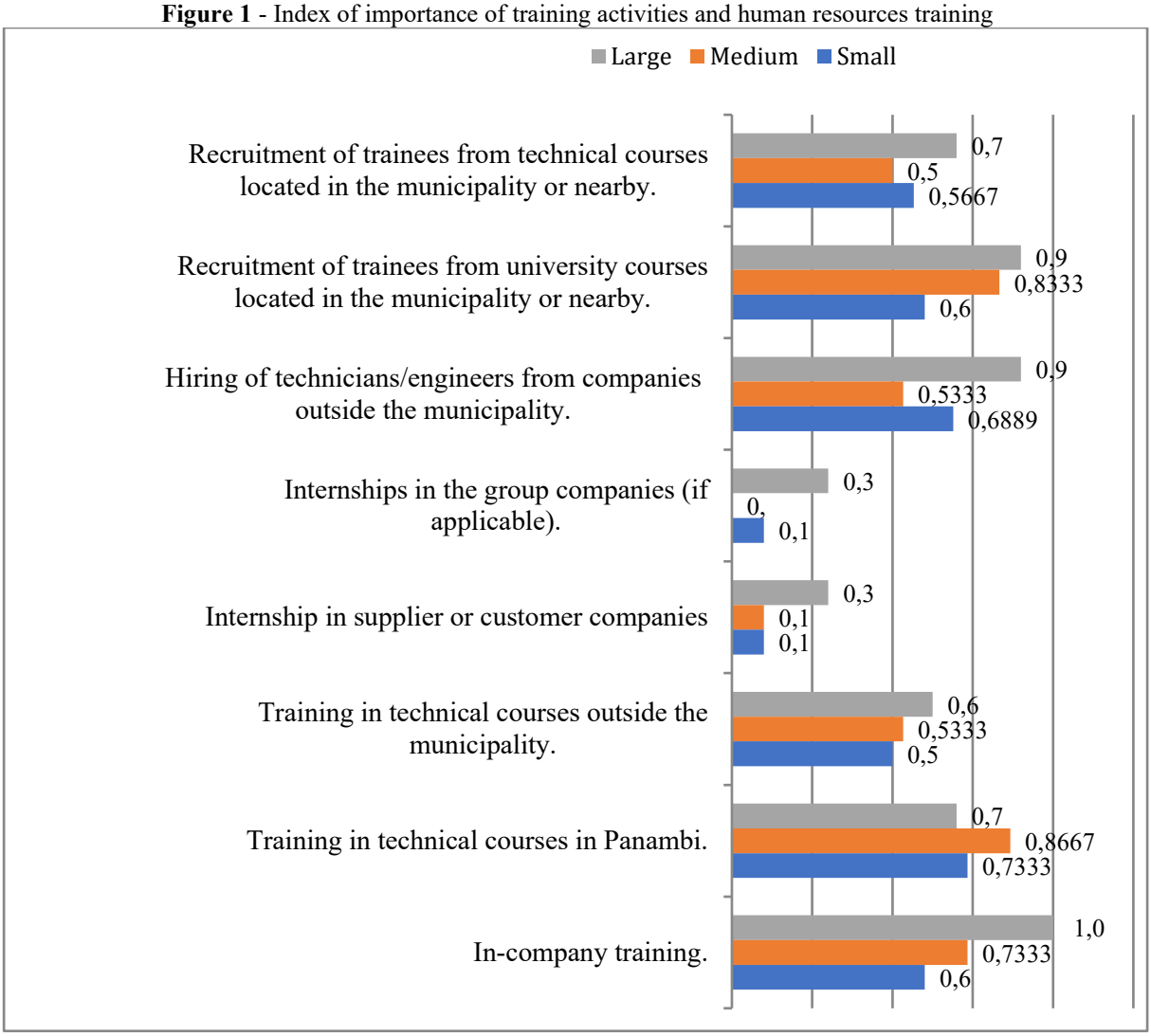
Figure 1 highlights the importance indexes for training and qualification of human resources. Small businesses, in general, traditionally allocate low volumes of resources to qualify their human resources. However, investments in employee training are barely distinguishable among the companies studied, especially with regard to training expenditures at the company itself. The research data suggest an anachronistic pattern of labor relations, since labor is still seen as a cost and not as a primary resource of production, paying little attention to the training and formation of qualified human resources, along the same lines of capability suggested by (FALCIOLA; JANSEN; ROLLO, 2019).

The companies identify that the technical courses available in the city provide access to specific knowledge related to the metal mechanic industry. In addition, professionals trained in university courses in the region are absorbed by companies of different sizes, with emphasis on medium and large companies. In this context, it is possible to observe that there is a high need for qualified professionals in the state of Rio Grande do Sul, in general, and in the region, in particular.

From the indicators presented in figure 1, it can be seen that the efforts in training and capability of human resources are more intensive in large and medium-sized companies. The field research pointed out that the quality of human resources is directly responsible for the results of the

companies. Although small companies report difficulties in investing in human resources training, most of them conduct training on a routine basis, especially through partnerships with suppliers and customers.

Figure 1 - Index of importance of training activities and human resources training



Source: Field Research, 2018.

The sources of information represent the origin of the acquired knowledge and learning, as shown in Table 1. In the study, it was noticed that technological learning occurs especially through informal or unstructured mechanisms, called in the economic literature *learning by doing and learning by using* [5] . In these ways of learning, the importance indexes were significant for all company sizes. The knowledge accumulated during the evolutionary trajectory of organizations was also relevant for all company sizes. While learning from R&D departments was less important (0.62) for small companies[6]. This result suggests that small companies do not have structured R&D departments and the innovative effort undertaken is basically by imitation. Reverse engineering was also indicated by

[5] See Betim *et al.* (2018) for a better understanding of the forms of learning.

[6] For Guerrero, Fonseca and Arend (2017), technological learning from R&D investments enables the dynamic capacity to face a constantly evolving technological paradigm.

companies as an important source of learning. The research identified that companies hardly invest in the creation and development of a totally new product / service, since they usually prefer to improve existing products.

Table 1 – Index of information sources importance for learning

Company size	Small	Medium	Large
Internal sources			
R&D Department	0,62	1,00	1,00
Production area	1,00	0,87	0,90
Sales and marketing areas, internal customer service	0,44	0,87	0,90
Knowledge accumulated over time	0,91	1,00	0,90
External sources			
Other companies within the group (if applicable)	0,23	0,30	0,45
Suppliers of inputs (equipment, materials)	0,64	0,50	0,60
Clients	0,96	0,87	0,75
Competitors	0,71	0,60	0,53
Through reverse engineering	0,71	1,00	0,90
Other Companies in the Sector	0,50	0,30	0,70
Universities and Other Research Institutes			
Universities	0,56	0,60	1,00
Research Institutes	0,43	0,40	0,70
Centers for professional training, technical assistance and maintenance	0,63	0,43	0,73
Testing and certification institutions	0,31	0,40	0,63
Other sources of information			
Conferences, Seminars, Courses and Specialized Publications	0,87	0,67	0,63
Fairs, Exhibitions and Shops	0,82	0,73	0,80
Leisure Meetings (Clubs, Restaurants, etc.)	0,82	0,20	0,38
Local business associations (including export consortia)	0,73	0,40	0,45
Internet or computer-based network information	0,91	0,73	0,90

Source: Field Research, 2018.

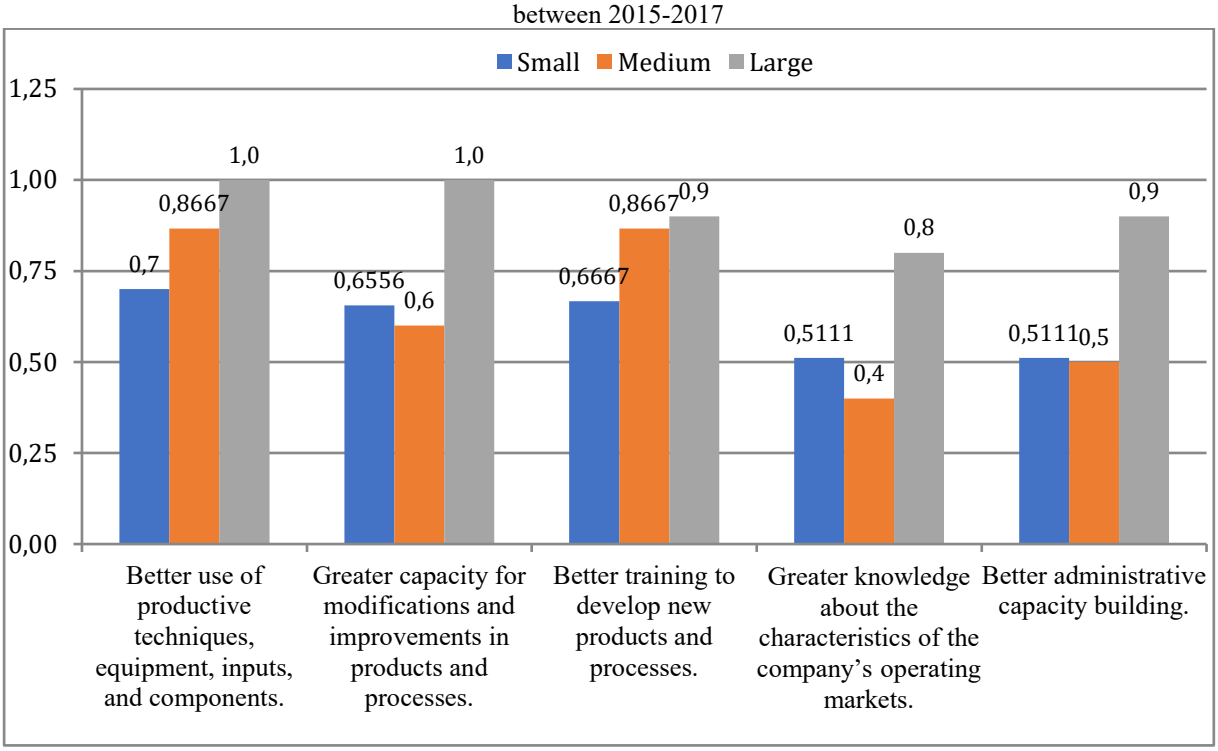
The partnership with local universities, which according to Betim *et al.* (2018) may imply more consistent interactions through learning by searching, showed a high level of relevance with regard to sources of information and learning. These institutions were considered relatively more important than research

institutes, professional training centers and testing and certification institutions. Therefore, there is a predisposition of companies to seek this way of learning, however, there are structural limitations of local support institutions, which make it impossible to deepen these relationships.

The results of the training processes and learning sources are shown in figure 2.

For all company sizes, the lessons learned have contributed to improving the capacity of companies to use their production techniques, equipment, inputs and components, as well as to greater competitiveness and training in the development of new products and processes, as pointed out by Dresch, Collatto, and Lacerda (2018).

Figure 2 – Index of importance of the results obtained with the training and learning processes carried out between 2015-2017



Source: Field Research, 2018.

Large companies have attributed a significant degree of importance to the accumulated training and learning, especially those associated with better use of inputs, machines and components for production, also greater training in making changes and improvements in products and processes. It is also noteworthy the great importance (0.87), conferred by medium-sized companies, associated with training in the development of new products and processes, in terms of maintaining competitive capacity, with the introduction of new products and processes that provide costs minimization.

The survey evaluated the innovative efforts of companies undertaken between the years 2015 and 2017. In these indicators, medium and large companies stand out, as they attribute significant relevance to all the analyzed items. According to Cattaruzzo (2020), the metal mechanic industry in Panambi - RS is classified as specialized suppliers (mechanical industry, engineering instruments, etc.), an activity in which the main focus is the innovation of products that will be used in other segments. In this type of company, there is a great effort to maintain and strengthen competitive capacity, in which these organizations have

4.2 The innovation processes

several innovative strategies[7]. We highlight the capability of human resources oriented to the search for innovative solutions and the introduction of industrial projects, aimed at improving products and processes. On the other hand, small firms have relatively low rates when compared to other companies, which demonstrates the existence of a direct relationship between the size of the establishment and the internal performance of R&D. A realização de Pesquisa e Desenvolvimento (P&D) nas empresas foi considerada relativamente importante para as empresas de todos os tamanhos. Contudo, os departamentos de P&D são, normalmente, formalizados nas empresas maiores, que apresentam condições de manterem profissionais dedicados exclusivamente à pesquisa e desenvolvimento de novos produtos e novos processos.

Research and development (R&D) in companies was considered relatively important for companies of all sizes. However, R&D departments are usually formalized in larger companies, which are able to maintain professionals exclusively dedicated to the research and development of new products and new processes.

Regarding the types of innovations made by companies, according to the company size, it can be seen that innovations were made in companies of all sizes, however the main characteristic of the innovations introduced is manifested in improvements of existing products for the national market. In general, most of these innovations are incremental and seek the improvement of products / services, which may be new only for the studied companies.

With regard to innovations in process, which involve new techniques, management mechanisms and more efficient production systems, it was possible to identify that the innovations were basically incremental, given that companies hardly adopt processes that do not exist in the market. It is noticed that this type of innovation occurs, predominantly, in medium and large companies, due to the greater financial capacity to make investments in productive processes already tested in the market.

The standardization of processes and products is a concern for companies, as they make investments to keep themselves in line with certification standards (ISO 9.000, ISO 14.000, etc.). The certification standards convey reliability to the market, as they demonstrate that several procedures of the organization are carried out according to the pre-defined standardization. It can be seen, based on the data exposed, that innovations occur in different ways in each company, as highlighted by Nelson (2017). In small companies, product innovations, new at the national level, occur to a lesser intensity, however, it is necessary to recognize the technological capacity and accumulated knowledge to carry out imitative innovations efficiently.

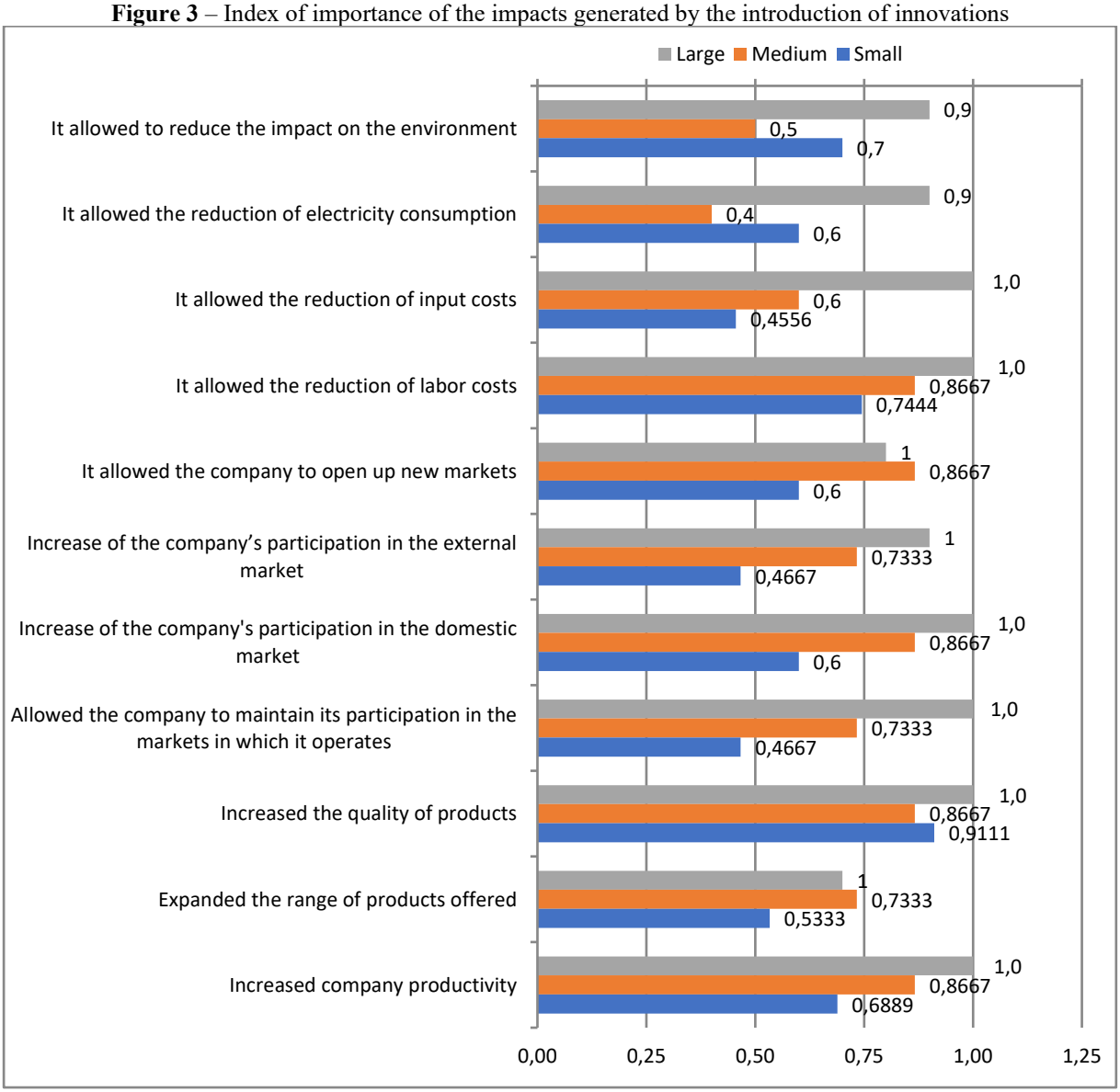
The impacts provided by the innovations carried out are shown in Figure 3. The main impact identified by the companies was the maintenance of competitiveness in the market in which they operate, which demonstrates the need for constant innovations, in products, processes, or even in organizational changes, as shown by Figueiredo and Pinheiro (2016).

For small companies, innovations help to keep them in the market competitively, largely because they are responsible for increasing the quality of their products. This provides better conditions for them to seek new markets and expand their production. Therefore, the innovative effort undertaken provides a reduction in costs, which makes it possible to undertake new investments, capable of boosting the development and growth of the company. The cost reduction, provided by

[7] For analysis of the innovative effort and to strengthen competitiveness see Dias (2018a).

the innovations in processes, also make it possible to reduce the negative impacts on the environment, in particular through a more efficient consumption of energy.

Figure 3 – Index of importance of the impacts generated by the introduction of innovations



Source: Field Research, 2018.

The impacts generated by the innovations introduced in the different sizes of companies are relatively similar, therefore, the positive result brought from the innovative efforts enabled the expansion of markets and expressive growth in products offer. However, for medium and large companies, increasing market share is extremely important for increasing competitiveness and expanding participation in the foreign market, respectively. In general, the effects generated by the introduction of technological innovations provide greater chances of development and growth for companies of all sizes.

5.3 Cooperation strategies

This section analyzes the cooperation processes identified in the study, namely: the forms of cooperation among companies, the types of subcontracting and the partnerships made by organizations, as well as the impacts generated on the possibilities of competitive insertion in the local and national market. Cooperation is seen as a central element for

social change and local development. This concept is reinforced in several studies, with emphasis on Colet and Mozzato (2018) and Dias (2018a).

Participation in cooperative activities of companies during 2017, according to size, was identified in all companies surveyed. The realization of cooperative activities among the companies demonstrates the high systemic articulation existing among the companies and the support institutions, which in turn can be a central element for the strengthening of the competitive capacity and the generation of a virtuous circle of local development.

In figure 4, it is possible to analyze the importance indexes attributed by companies to several types of cooperative activities that are developed in this industry. It is noteworthy that partnerships for the development of products and processes are relevant actions for companies. In general, small companies are less involved in cooperative activities. The explanation for this finding lies in the fact that these companies have greater difficulties in long-term planning, as they are more concerned with their capital limitations and competitive difficulties.

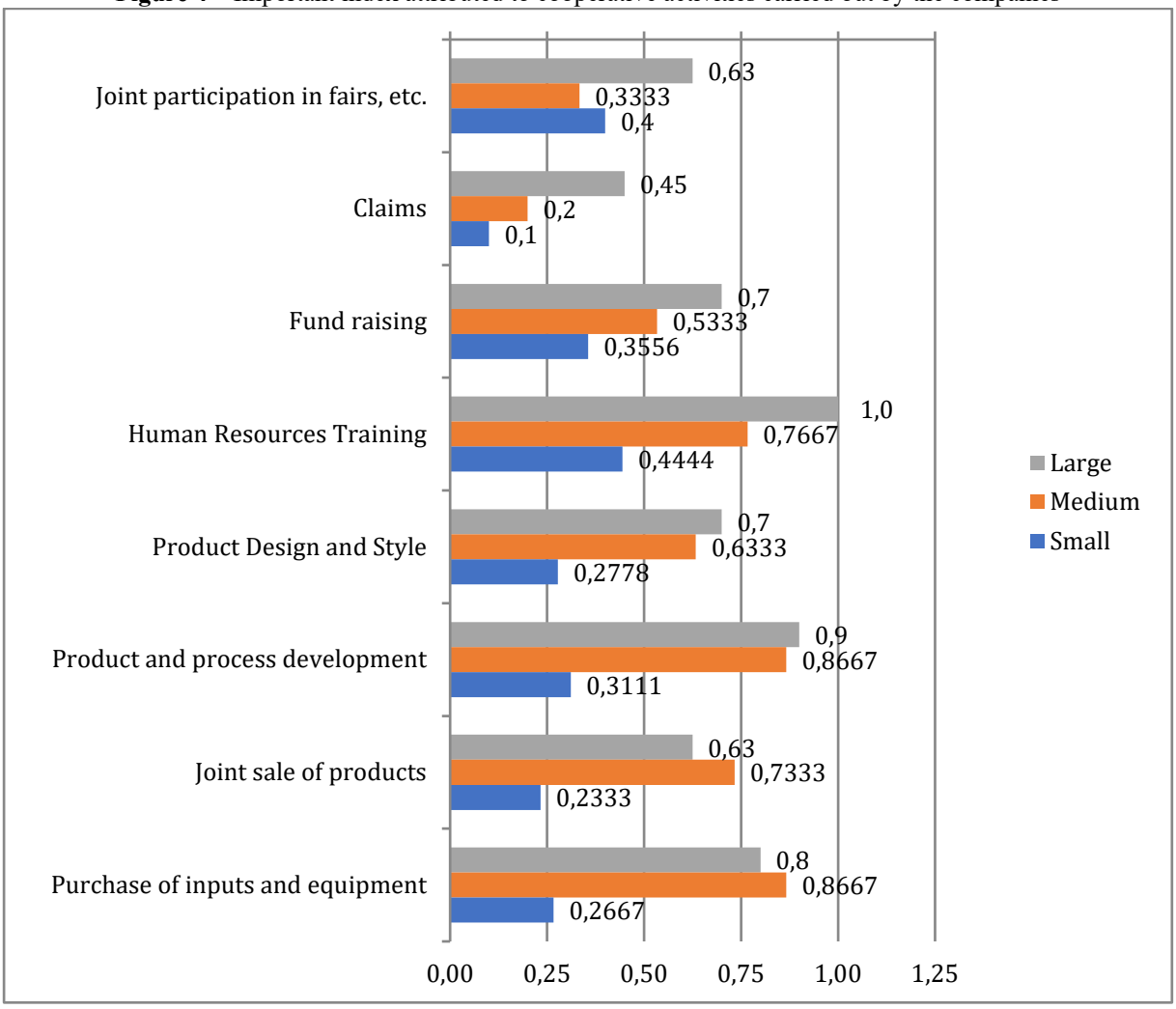
The cooperative activities carried out were predominantly with clients and with professional training centers for technical assistance and maintenance. Among small companies, there are important relationships with suppliers of inputs and universities. The relationship with suppliers enables increases in production capacity, with improvement in processes, through feedback mechanisms between the producer of raw materials and consumers.

The interactions with customers contribute a lot to the understanding of needs and expectations of the consumer market, as it enables significant learning associated with the use of products (learning by using). The partnerships established with universities enable learning by interaction, which reinforces the capacity to carry out research and development, especially with the development of new technologies associated with this regional productive specialization.

As discussed in Nelson (2017), the research showed difficulties in carrying out cooperation with support and promotion agencies, which may be a sign of a lack of agencies capable of articulating the integration among companies in a systemic way. Due to their productive and competitive characteristics, small companies have a low relationship with representative institutions and research institutes, which are entities capable of disseminating the knowledge required for the improvement of productive techniques.

Larger companies, as they have better structural and financial conditions, develop partnerships with consulting and technical assistance organizations, which enable a constant updating of technologies available on the market. These relationships may promote innovations in the methods of management and organizational processes, as well as help in the resolution of productive and administrative problems. In this regard, these companies benefit from their structural stability to undertake innovative efforts with a greater impact on the market in which they operate.

Figure 4 – Important index attributed to cooperative activities carried out by the companies



Source: Field Research, 2018.

For larger companies, cooperative activities are important for their development and competitive insertion. In general, the cooperation activities carried out among the companies of this productive system and the other support institutions contributed to the competitive insertion and the implementation of innovative efforts by the companies. However, small companies still do not participate actively in this process, so they present less articulation and, consequently, more modest results from eventual partnerships made.

6 CONCLUSIONS

The local characteristics presented by the metal mechanic production system were influenced, to a certain extent, by its historical formation, marked by the specialization in agricultural production. European immigration provided basic knowledge to start the activities of some companies in the city. The interaction among suppliers of local machines and equipment has persisted since the beginning of this industry in the region to the present day, in order to allow the exchange of technological knowledge to contribute significantly to the competitive insertion of companies in the domestic and foreign markets.

The creation of new companies started from the development of practical (applied) skills of specialized workforce, since some professionals became entrepreneurs and started to work in certain niche markets, or even in supply, for medium and large companies, of products

or services for certain stages of the production process.

In general, specific characteristics of productive agglomerations were found in the companies studied, with technological training processes and innovative efforts based on *learning-by-doing* and *learning-by-using*, as described in the Neo-Schumpeterian literature. Notably, it was found that companies with a high division of labor and productive specialization live with companies that establish low interactive links with local agents. In general, in the aforementioned environment, there is a local productive and innovative system, created based on the following elements: i) division of labor and productive specializations; ii) efforts for the technological and organizational qualification of companies; iii) relationships that are established locally; iv) benefits from proximity and; v) territorial organization.

The innovative effort made by companies is predominantly related to incremental and imitative innovations. However, there was the presence of cooperative activities, which were carried out among medium and large companies with the support institutions, which demonstrate the existence of local synergies that can densify the local productive system, with the establishment of a virtuous circle of growth and development. The densification of the productive structure can strengthen local complementarities, especially in the sense of boosting the innovative effort undertaken by companies.

In summary, the study hypothesis was partially proved that the formation and trajectory of this agglomeration of companies allows cooperative actions of a productive, technological and institutional scope to gradually strengthen the learning mechanisms, especially through interactions, and contribute to the accumulation of knowledge, as well as capability in innovative processes, which can evolve beyond imitative and incremental innovations. Thus, the main contribution of the study, based on the chosen theoretical framework, was to identify the ways of learning, the types of innovation, and the main cooperative actions carried out at the regional level.

REFERÊNCIAS

BETIM, L. M.; REZENDE, L. M., ANDRADE JUNIOR, P. P. de; PONTES, J.; PETTER, R. R. H. Relações verticais e horizontais no processo de inovação e aprendizagem interativa: estudo em um aglomerado produtivo. **Gestão & Produção**, v. 25, n. 2, p. 205-218, mai. 2018. DOI https://dx.doi.org/10.1590/0104-530x1028-16

BHAWSAR, P.; CHATTOPADHYAY, U. Competitiveness: review, reflections and directions. **Global Business Review**, v. 16, n. 4, p. 665-679, 2015. DOI: https://doi.org/10.1177/0972150915581115

CANTNER, U. Foundations of Economic Change: An Extended Schumpeterian Approach. *In*: CANTNER, U; PYKA, A (Org.) **Foundations of Economic Change**. Springer, /Cham, 2017. p. 9-49. DOI https://doi.org/10.1007/978-3-319-62009-1

CATTARUZZO, S. **On R&D sectoral intensities and convergence clubs**. Joint Research Centre (JRC) Working Papers on Corporate R&D and Innovation, n. 01. Seville: European Commission, 2020.

COLET, D. S.; MOZZATO, A. R. A cooperação no contexto das transformações sociais e desenvolvimento local: o da rota das Salamarias – RS. **Revista Gestão e Regionalidade**, v. 34, n. 102, p. 179-191, set./dez 2018.

COSTA, Vítor M. V. **Capacidade de absorção e processos organizacionais de gestão do conhecimento: relações com a inovação**. Tese (Doutorado). Univ. Beira do Interior, Covilhã, 2017.

CURADO, M.; FERNÁNDEZ, V. L. O mito da leniência fiscal no pensamento econômico desenvolvimentista. **Economia e Sociedade**, v. 27, n. 1, p. 61-87, 2018.

DIAS, M. C. Inovação, aprendizagem e cooperação na cadeia de suprimento têxtil da região de Americana – SP. **Revista Gestão e Regionalidade**, v. 34, n. 100, p. 127-144, jan./abr. 2018a.

DIAS, A. **A inovação a partir do processo de subcontratação nas indústrias do setor metalmecânico no Município de Santa Rosa/RS**. Dissertação (Mestrado), UFFS, Cerro Largo, 2018b.

DRESCH, A.; COLLATTO, D. C.; LACERDA, D. P. Theoretical understanding between competitiveness and productivity: firm level. **Ingeniería y competitividad**, v. 20, n. 2, p. 69-86, 2018.

DOPFER, K.; POTTS, J.; PYKA, A. Upward and downward complementarity: the meso core of evolutionary growth theory. *In*: CANTNER, U; PYKA, A (Org.) **Foundations of Economic Change**. Springer, Cham, 2017. p. 69-80. DOI https://doi.org/10.1007/978-3-319-62009-1

STALLIVIERI, F. Dinâmica econômica e a inserção de micro e pequenas empresas em arranjos produtivos locais: o caso da eletrometal-mecânica da microrregião de Joinville/SC. Dissertação (Mestrado em Economia), UFSC, Florianópolis, 2004.

FALCIOLA, J.; JANSEN, M.; ROLLO, V. Defining firm competitiveness: A multidimensional framework. **World Development**, v. 129, 10485, 2020.

FIGUEIREDO, P. N.; PINHEIRO, M. C. Competitividade industrial brasileira e o papel das capacidades tecnológicas inovadoras: a necessidade de uma investigação criativa. **Technological Learning and Industrial Innovation Working Paper Series**, n. 1, 2016.

FONSECA, P. C. D.; SALOMÃO, I. C. O Sentido Histórico do Desenvolvimentismo e sua Atualidade. **Revista de Economia Contemporânea**, v. 21, n. 2, p. 1-20, 2017.

GUERERRO, G. A.; FONSECA, P. C. D.; AREND, M. The heterogeneity of the machine tool industry in Brazil. Revista Economia. v. 18, n. 2, p. 260-274, maio/ago 2017. DOI https://doi.org/10.1016/j.econ.2017.01.003.

-GUERRERO, G. A.; FONSECA, P. C. D. Trajetória e dinâmica tecnológica da indústria de máquinas-ferramenta no Brasil. **Economia e Sociedade**, Campinas, SP, v. 27, n. 1, p. 287–319, 2018. Disponível em: https://periodicos.sbu.unicamp.br/ojs/index.php/ecos/article/view/8652549. Acesso em: 12 fev. 2021.

IACONO, A.; NAGANO, M. S. Aprendizagem Tecnológica: uma Análise da Contribuição dos Mecanismos de Aquisição e Conversão do Conhecimento para o Acúmulo da Capacidade Tecnológica. **Revista de Gestão dos Países de Língua Portuguesa**, v. 18, n. 2, p. 146-168, 2019.

KREIN, J. D.; OLIVEIRA, R. V. de; FILGUEIRAS, V. A. AS REFORMAS TRABALHISTAS: promessas e impactos na vida de quem trabalha. **Caderno CRH**, v. 32, n. 86, p. 225-229, 2019.

LUNDVALL, B. **The learning economy and the economics of hope**. Anthem Press, London, 2016.

MENDES, H.; FERREIRA, M. L. A. Tecnologia Industrial Básica (TIB) no Setor Metalmecânico: um Estudo Exploratório no Rio de Janeiro. **Cadernos do Desenvolvimento Fluminense**, n. 14/15, p. 80-99, 2018.

MORCEIRO, P. C. **Sectoral demand leakage and competitiveness of the Brazilian manufacturing industry**. Working Paper Series nº 2016-12. FEA/USP, 2016.

NELSON, R. R. Behavior and cognition of economic actors in evolutionary economics. In: CANTNER, U; PYKA, A (Org.) **Foundations of Economic Change**. Springer, Cham, 2017. p. 51-67. DOI https://doi.org/10.1007/978-3-319-62009-1

RAIS**. Relação Anual de informações sociais 2016**. Disponível em: http://bi.mte.gov.br/bgcaged/login.php. Acesso em: 12 mai. 2018.

---

[i] **Fabiano Geremia**
Professor de economia da indústria e da tecnologia

[ii] **Thales de Oliveira Costa Viegas**
Professor do Departamento de Economia da Universidade Federal de Santa Maria Campus de Palmeira das Missões – RS.

[iii] **Claudio José Silva Leão**
Professor do Departamento de Economia da Universidade Federal de Santa Maria Campus de Palmeira das Missões – RS.

[iv] **Rafael Alves de Moura**
Bacharel em economia pela Universidade Federal de Santa Maria (UFSM).